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(54) Soluble recombinant Fc-Epsilon-receptor, the preparation and the use thereof.

(57) The present invention describes the expression of highly bioactive water-soluble Fc ϵ R in cells derived from multicellular organisms and the use thereof.

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Soluble recombinant Fc_ε-receptor, the preparation and the use thereof

The molecular structure of Human Lymphocyte Receptor for Immunoglobulin (Fc_εR) as well as its cloning and expression was recently described in the literature by Tadimitsu Kishimoto et al. (see Cell 47, 657-665 (1986)) and by Guy Delespesse et al. (see The Embo Journal 6, 109-114 (1987)). The molecular structure of Fc_εR (see Figure 1) indicates that it is oriented on the cell membrane with its N-terminus inside the cell and its carboxy terminus exposed outside the cell.

Furthermore, the residue at position 150 of Fc_εR is a potential cleavage site for trypsin-like proteases, which explains the presence of soluble components of Fc_εR in culture supernatants of B cells and certain B lymphoblastoid cell lines. This may be the reason for the presence of water-soluble Fc_εR or a portion of it associated or complexed to IgE in the serum of normal and atopic individuals, with significantly higher levels in the latter group.

Moreover, in the not yet published European Patent Application Nr. 87111392.4 are described a cDNA-sequence, wherein at least a part of the cDNA sequence coding for the amino acids 1 to 148 is replaced by a suitable cDNA fragment coding for an eucaryotic signal sequence. Thus, in the described plasmid psFc_εR-1 (see Figure 4) the coding sequence for the amino acids 1 to 133 is replaced by the BSF-2 signal sequence as follows:

The plasmid LE392 (see Cell 47, 657-665 (1986)) deposited under the terms of the Budapest Treaty under FERM BP-1116 on August 01, 1986 was digested with HindIII, whereby a 1.0 kbp HindIII-fragment was obtained containing the coding sequence for the amino acids 134 to 321 of the full-length Fc_εR cDNA. The recessed 3'-ends of this fragment were then filled in with the Klenow fragment of DNA polymerase and the DNA subsequently digested with PstI. The obtained fragment was then cloned in a suitable vector, preferably with a BamHI-PstI digested pBSF2-L8, whereby this vector is conveniently prepared as follows:

The EcoRI-BamHI 1.2 kbp BSF-2 cDNA insert was prepared by digestion of pBSF-2.38 (see Nature 324, 73-76 (1986)) with HindIII and BamHI. The obtained fragment containing a full length BSF-2 cDNA was then digested with HinfI and the recessed 3'-end filled in with Klenow fragment of DNA polymerase. After KpnI digestion, the obtained KpnI-HinfI 110 bp fragment containing the BSF-2 leader sequence was cloned into the multiple cloning site of pGEM4 digested previously with KpnI and SmaI. One of the selected clones was propagated and named as pBSF2-L8 (see

Figure 3).

pBSF2-L8 was digested with BamHI and the recessed 3'-ends filled in with Klenow fragment of DNA polymerase. After the filling in of the BamHI site, the above mentioned HindIII-PstI Fc_εR cDNA was cloned into BamHI-PstI digested pBSF2-L8 as mentioned hereinbefore. One of the selected clones was propagated and named as psFc_εR-1 (see Figure 4).

Surprisingly it was found, that when expressing such a coding sequence wherein at least a part of the cDNA sequence coding for the amino acids 1 to 148 is replaced by a suitable cDNA fragment coding for an eucaryotic signal sequence, in cells derived from multicellular organisms a highly bioactive water-soluble Fc_εR is obtained. Hereby, in principle, any cell culture is workable, whether using vertebrate or invertebrate cells. However, interest has been greatest in vertebrate cells, and propagation of vertebrate cells in culture (tissue culture) has become a routine procedure in recent years (Tissue Culture, Academic Press, Kruse and Patterson, Editors (1973)). Examples of such useful host cell lines are VERO and HeLa cells, Chinese hamster ovary (CHO) cell lines, and W138, BHK, COS-7 and MDCK cell lines. Expression vectors for such cells ordinarily include (if necessary) an origin of replication, a promotor located in front of the gene to be expressed, along with any necessary ribosome binding sites, RNA splice sites, polyadenylation site, and transcriptional terminator sequences.

For use in mammalian cells, the control functions on the expression vectors are often provided by viral genome. For example, commonly used promoters are derived from polyoma, Adenovirus 2, and most frequently Simian Virus 40 (SV40). The early and late promoters of SV40 are particularly useful because both are obtained easily from the virus as a fragment which also contains the SV40 viral origin of replication (Fiers et al., Nature 273, 113 (1978)). Smaller or larger SV40 fragments may also be used, provided there is included the approximately 250 bp sequence extending from the Hind III site toward the Bgl I site location in the viral origin of replication. Further, it is also possible, and often desirable, to utilize promotor or control sequences normally associated with the desired gene sequence, provided such control sequences are compatible with the host cell systems.

An origin of replication may be provided either by construction of the vector to include an exogenous origin, such as may be derived from SV40 or other viral (e.g., Polyoma, Adeno, VSV, BPV, etc.) source, or may be provided by the host cell chromosomal replication mechanism. If the vector

is integrated into the host cell chromosome, the latter is often sufficient.

However, most preferably a cloning vehicle (shuttle plasmid) is used which enables replication in eukaryotes as well as in prokaryotes. The plasmid's ability to replicate in prokaryotes provides easy means for manipulating the DNA sequence and getting hold of large quantities of plasmid DNA needed for transfection into mammalian cells.

Such a shuttle plasmid contains prokaryotic DNA motifs as well as DNA sequences derived from eukaryotes.

The prokaryotic part of the plasmid consists of an origin of replication usually derived from the plasmid pBR322 (Mulligan R.C. et al. in Proc. Natl. Acad. Sci. USA 78, 2072-2076 (1981)) and a marker gene facilitating selection on antibiotic containing medium. The most widely used genes for selection are those mediating resistance to either ampicillin, tetracycline or chloramphenicol (Mulligan R.C. et al. in Proc. Natl. Acad. Sci. USA 78, 2072-2076 (1981)).

The eukaryotic part of the shuttle plasmid has to contain an origin of replication, usually derived from viral genomes such as Simian 40 Virus (Mulligan R.C. et al. in Proc. Natl. Acad. Sci. USA 78, 2072-2076 (1981)) or Bovine Papilloma Virus (DiMaio D. et al. in Mol. Cell. Biol. 4, 340-350 (1984)). Secondly a selectable marker gene is required to enable the cells harbouring the shuttle plasmid to grow under selective conditions in order to maintain the plasmid in the cells. This marker gene may be either of prokaryotic or of eukaryotic origin (e.g. prokaryotic genes: gpt gene coding for xanthine-guanine phosphoribosyltransferase (Mulligan R.C. et al. in Proc. Natl. Acad. Sci. USA 78, 2072-2076 (1981)), Mulligan R.C. et al. in Science 209, 1422 (1980)), neo gene coding for a bacterial phosphatase mediating resistance to the neomycin derivative G418 (Southern P. et al. in J. Mol. Appl. Genet. 1, 327 (1982), Scholer U. et al. in Cell 36, 1422 (1984), CAT gene coding for the chloramphenicol acetyl transferase (Gorman C. in Mol. Cell. Biol. 2, 1044 (1982)); eukaryotic genes: gene coding for the thymidine kinase (Wigler M. et al. in Cell 11, 223 (1977)). The third eukaryotic DNA motif enabling expression of the cloned gene of interest is a promoter sequence, which may be either constitutive or inducible (e.g. constitutive promoter: simian 40 virus or rous sarcoma virus (Mulligan R.C. et al. in Science 209, 1422 (1980), Laimons L. et al. in Proc. Natl. Acad. Sci. USA 79, 6453 (1982)); inducible promoter: mouse mammary tumor virus promoter (Chapman A.B. et al. in Mol. Cell. Biol. 3, 1421-1429, heat shock protein promoter (Pelham H. et al. in EMBO J. 1, 1473 (1982)), metallothionein promoter (Mayo K. et al. in Cell 29, 99 (1982), Karin M. et al. in Nature 299, 797

(1982)).

One way to get hold of relatively high quantities of the soluble part of the Fc_ε-receptor protein in higher eukaryotes is to anneal the soluble part of the Fc_ε-receptor gene to the SV 40 promoter (constitutive) and clone this hybrid gene into a plasmid containing the gene coding for the dihydrofolate reductase (dhfr). Under selective pressure the dhfr gene and the adjacent DNA sequences are amplified up to a thousand times, elevating the yield not only of the dhfr gene but the soluble Fc_ε-receptor part as well (EP-A-0 093 619).

A preferred embodiment of the present invention, however, is a vector suitable for expression in cells of multicellular organisms containing the above mentioned coding sequences of psFc_εR-1 as shown in Figure 4, the cells transfected with such a vector, the corresponding genes operably linked with a suitable replicon and control sequences, the expressed water-soluble Fc_εR and processes of the preparation thereof.

For example, such a vector according to the invention can be prepared using as basic vector the PDE-2, pSV2 or π H3M vector as follows:

a) The expression vector PDE-2 (see Japanese Pat. Publication 1986/88879) which bears two SV40 early promoters was digested with EcoRI using standard techniques, and ligated with the EcoRI fragment of psFc_εR-1 containing the BSF₂ leader sequence (as shown in Figure 2). The resulting expression vector construct PDE-2sFc_εR was utilised for expression in monkey Cos-7 cells.

b) After digestion of the expression vector π H3M (see Proc. Natl. Acad. Sci. 84, 3365-3369 (1987)) with XhoI, the linearized plasmid was made blunt-ended with Klenow fragment in the presence of dNTP. Subsequently the vector was treated with bacterial alkaline phosphatase, extracted with phenol and precipitated.

In parallel the plasmid psFc_εR-1 (containing the soluble part of the Fc_ε-receptor gene and the BSF-2 leader sequence upstream of the gene) was digested with EcoRI. After Klenow fill in reaction the DNA fragment was electroeluted.

The linearized, dephosphorylated π H3M vector was ligated to the BSF-2sFc_ε-DNA fragment. The resulting plasmid was transformed into E.coli and propagated and designated π sFc_εR.

c) After digestion of the expression vector pSV2 gpt (see Science 209, 1422 (1980)) with EcoRI and BamHI, the obtained DNA was precipitated with ethanol and subsequently treated with the Klenow fragment. After inactivation of the enzyme, the DNA was treated with calf intestine alkaline phosphatase, extracted with phenol, purified over agarose gel and electroeluted.

In parallel, the pBR322-dhfr plasmid containing the gene for the dihydrofolate reductase (dhfr) and

the corresponding regulatory region derived from hamster cells (see Mol. Cell. Biol. 6, 425-440 (1986)) was digested with FspI and HindIII.

After ethanol precipitation the isolated 2658 bp DNA fragment was made blunt-ended and purified over agarose gel and electroeluted.

The thus obtained DNA fragment and the modified pSV2 gpt vector were ligated and transfected into E.coli JM101. After restriction enzyme analysis with EcoRI and MstII two positive clones differing in the orientations of the dhfr-gene in respect to SV40 ORI were selected and designated pSV2 gpt-dhfr17 resp. pSV2 gpt-dhfr20.

One of the obtained pSV2 gpt-dhfr vectors was digested with Apal and treated with Klenow enzyme. After phenol:chloroform extraction and ethanol precipitation, the obtained DNA was incubated with HindIII and after inactivation of the enzyme with calf intestine alkaline phosphatase. The desired pSV2-dhfr vector, which does not contain the gpt gene, was obtained by extraction with phenol:chloroform, by chromatography over agarose gel and by electroelution. The thus isolated pSV2-dhfr vector was ligated with a DNA fragment containing the coding sequence for the soluble part of Fc_εR which upstream is ligated to the BSF-2 leader sequence. This fragment is preferably prepared by digestion of the μ H3M plasmid containing the soluble part of the Fc_ε-receptor gene which upstream is ligated to the BSF-2 leader sequence with PstI, incubation of the obtained reaction mixture with the Klenow enzyme in the presence of dNTP to create blunt ends, followed by phenol extraction and ethanol precipitation. The obtained DNA was incubated with HindIII, extracted with phenol:chloroform and purified over agarose gel. After electroelution of the isolated 1.500 bp fragment, the fragment was ligated with the linearized pSV2-dhfr vector and transfected into E.coli HB 110. After restriction enzyme analysis two positive clones were selected and designated pSV2-dhfr17-sFc_ε and pSV2-dhfr20-sFc_ε. The resulting expression vectors were utilized for expression in chinese hamster ovary cells.

In addition to microorganisms, cultures of cells derived from multicellular organisms may also be used as hosts. In principle, any such cell culture is workable, whether from vertebrate or invertebrate culture.

Propagation of cells in culture (tissue culture) has become a routine procedure (Tissue Culture, Academic Press, Kruse and Patterson, Editors (1973)). Examples of vertebrate host cell lines are VERO and Hela cells, Chinese hamster ovary (CHO) cell lines and WI38, BHK, Cos-7 and MDCK cell lines; but also invertebrate cell lines have become useful in recent years (e.g. 8f9 cloned cell line from *Spodoptera frugiperda* cells; available

from ATCC).

Expression vectors for such cells ordinarily include (if necessary) an origin of replication, a promoter located in front of the gene to be expressed, along with any necessary ribosome binding sites, RNA splice sites, polyadenylation site, and transcriptional terminator sequences.

For use in mammalian cells, the control functions on the expression vectors are often provided by viral genome. For example, commonly used promoters are derived from polyoma, Adenovirus 2, and most frequently Simian Virus 40 (SV40); for invertebrates e.g. the promoter from the polyhedrin gene of *Autographa californica* nuclear polyhedrosis virus (AcNPV) (Summers M.D. and Smith G.E.; A Manual of Methods for Baculovirus Vectors and Insect Cell Culture Procedures (1987) Department of Entomology, Texas, Agricultural Experiment Station and Texas A & M University).

The early and late promoters of SV40 are particularly useful because both are obtained easily from the virus as a fragment which also contains the SV40 viral origin of replication (Fiers et al., Nature 273, 113 (1978)). Smaller or larger SV40 fragments may also be used, provided there is included the approximately 250 bp sequence extending from the HindIII site toward the BglI site location in the viral origin of replication. Further, it is also possible, and often desirable, to utilise promoter or control sequences normally associated with the desired gene sequence, provided such control sequences are compatible with the host cell systems (e.g. the DMFR-gene for CHO-cells).

An origin of replication may be provided either by construction of the vector to include an exogenous origin, such as may be derived from SV40 or other viral (e.g., Polyoma, Adeno, VSV, BPV, AcNPV etc.) source, or may be provided by the host cell chromosomal replication mechanisms. If the vector is integrated into the host cell chromosome, the latter is often sufficient.

However, most preferably a cloning vehicle (shuttle plasmid) is used which enables replication in eukaryotes as well as in prokaryotes. The plasmids's ability to replicate in prokaryotes provides easy means for manipulating the DNA sequence and getting hold of large quantities of plasmid DNA needed for transfection into mammalian cells.

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Transfer of foreign DNA into appropriate host cells can be managed by microinjection of DNA directly into the cell nucleus of the host cell (Capecchi M. in Cell 22, 479 (1980)); protoplast fusion of the bacterial protoplast carrying foreign DNA with the eucaryotic host cell (Schaffer W. in Proc. Natl. Acad. Sci. USA, 77, 2163 (1980)); electroporation of the host cell membrane in the presence of DNA being transfected (Neuman E. et al. in EMBO J., 1, 841 (1982)); fusion of liposomes containing recombinant DNA with host cells (Fraleigh R. et al. in J. Biol. Chem. 255, 10431 (1980)). Most frequently used methods are the co-precipitation between DNA and calcium phosphate (Graham, F.L. and van der Erb., A.J. in Virology 52, 456 (1973)) and DEAE-dextran mediated transfection (Vaehri A. et al. Virology 27, 435 (1965)).

After incubation the transfected cos-7 or CHO

cells, the culture supernatants were collected to test for soluble Fc ϵ R as follows:

The Cos cell supernatants were tested on an eosinophilic cell line, EoL-3 which expresses Fc ϵ R, the presence of such receptors have been tested utilising monoclonal antibodies specific to Fc ϵ R (8-30) as described in European Patent Application No. 87110658.9 of the same applicant. As shown on Figure 5, these cells stain for Fc ϵ R with 8-30 antibodies compared to the controls.

Furthermore, Fc ϵ R on cells are detected by an assay with the use of fixed ox RBC (ORBS) coated with human IgE (Gonzalez-Molina, A. and Spiegelberg, H.L. J. Clin. Invest. 59, 616 (1977)). The number of IgE rosette-forming cells is estimated after subtracting the number of non-specific binding with fixed ORBC coated with bovine serum albumin.

The IgE-binding activity found in the PDE-2sFc ϵ R transfected Cos cell supernatant was analysed by its inhibitory activity on the binding (rosette-formation) of IgE-ORBC to the EoL-3 cells. The results shown on Table I indicate that the soluble Fc ϵ R is capable of inhibiting competitively the binding of IgE to its receptors.

The presence of soluble receptor activity was confirmed by the ELISA assay as described below:

The Fc ϵ R activity was measured by its ability to bind to the monoclonal antibodies 3-5 and 8-30 and monitored utilising a double antibody enzyme-linked immunosorbent assay (ELISA). Whereas no Fc ϵ R activity was detected in the supernatants of control Cos-7 cells, there was significant secretion of receptor activity in the PDE-2sFc ϵ R-transfected Cos-7 cells. In fact, the level of Fc ϵ R activity was 5 and 25 units/ml in transfectant culture supernatants containing 1 % and 10 % fetal calf serum (FCS) respectively. The results of Fc ϵ R activity are shown on Figure 6.

Similar results were obtained when using water-soluble Fc ϵ R isolated from transfected CHO cells.

Moreover, it is known, that immediate-type hypersensitivity can be manifested as a broad spectrum of symptoms ranging from seasonal rhinitis to anaphylaxis. The mechanism of immediate hypersensitivity involves IgE antibodies and reactive cells such as tissue mast cells and basophils which bear on their surface specific receptors for these antibodies. Upon triggering of those cells by specific allergens, a cascade of biochemical events lead to the release of preformed mediators from the cellular granules and newly synthesized lipid metabolites of membrane arachidonic acid, these agents cause an inflammatory process characterised by increased vascular permeability, smooth muscle contraction and all the symptoms associated with such a reaction. The process is am-

plified by the chemotaxis of cells such as neutrophils and eosinophils which in turn will enhance the reaction by releasing their own proinflammatory components. A family of factors specific for the eosinophils are the eosinophil chemotactic factors of anaphylaxis, these are acidic tetrapeptides and attract eosinophils to the site of the allergic reaction. More recent findings indicate the importance of eosinophils in allergy and in parasitic infestations. It has been demonstrated that the eosinophils bear on their surface receptors for IgE (Fc_εR) which in the presence of IgE can actively participate in IgE-mediated events characterised by degranulation and further amplification of the inflammatory process. Furthermore, the Fc_εR found on eosinophils is of low affinity compared to that found on mast cells and basophils. In view of the mounting importance of eosinophils in immediate-type hypersensitivity and particularly asthma it is important to find means to control the IgE-mediated degranulation of these cells. Moreover, the central issue is to prevent or compete with the binding of IgE to mast cells, basophils and eosinophils. It has been hypothesised that IgE-binding factors might be able to achieve that either by controlling IgE biosynthesis or by neutralising or scavenging serum IgE.

The before mentioned evidence shows that the water-soluble Fc_εR prepared according to the present invention binds IgE and in its soluble form it can prevent the binding of IgE to eosinophils which are known to be involved in certain aspects of immediate hypersensitivity (allergy) and particularly asthma.

Therefore, the soluble Fc_εR prepared according to the invention is useful in controlling the inflammatory effects of allergy and is suitable for the treatment or prophylaxis of local and allergic reactions induced by IgE, which is a further object of the invention.

The soluble Fc_εR may be incorporated for the pharmaceutical use in the suitable pharmaceutical compositions, such as solutions or sprays.

The following examples, which are not exhaustive, will illustrate the invention in greater detail:

Example A

The monoclonal anti-Fc_εR antibodies 3-5 (γ₁) and 8-30 (μ) were produced by hybridization of P3U1 myeloma with spleen cells from Balb/c mice immunized with RPMI-8866 cells (see European Patent Application No. 86 110 420.6 of the same Applicant, filed on July 29, 1986). The 8-30 antibody recognizes the epitope close to IgE binding site of Fc_εR and can block binding of IgE to 8866 lymphoblastoid cells. The 3-5 antibody, recognizes

a different epitope on Fc_εR and can not block effectively IgE binding to its receptors. These antibodies precipitate 46 kd and 25 kd polypeptides under reducing and non reducing conditions. The monoclonal antibodies were purified from ascitis by 50 % saturated ammonium sulfate precipitation followed by gel filtration using Sepharose 6B (Pharmacia Fine Chemical, Uppsala, Sweden) for IgM class or ion exchange chromatography using QAE-Sephadex (Pharmacia Fine Chemical) for IgG1. The polyclonal mouse IgG was isolated in the same fashion. The anti-mouse IgM-alkaline phosphatase conjugate was purchased from Tago (Burlingame, CA).

Example B

Construction of plasmid psFc_εR-1

a) 350 μg of pBSF2-38 (see Nature 324, 73-76 (1986)), which contains the BSF-2 cDNA in the SmaI site of pGEM4, were digested with 700 units of EcoRI and BamHI in 500 μl of a high salt buffer (100 mM NaCl, 50 mM Tris-HCl, pH 7.5, 10 mM MgCl₂, 1 mM DTT) for 2 hrs at 37 °C. The digested DNA was applied on a preparative 1 % agarose gel electrophoresis and the EcoRI-BamHI fragment containing the full-length 1.2 kbp BSF-2 cDNA was electroeluted from the gel, precipitated with 70 % ethanol and dissolved at a concentration of 1 μg/μl in TE buffer. 20 μg of this fragment were digested with 40 units of HinfI in 50 μl of a high salt buffer for 1 hr, phenol-extracted and ethanol-precipitated. The digested DNAs were dissolved in 25 μl of 1 x nick translation buffer (50 mM Tris-HCl, pH 7.2, 10 mM MgSO₄, 0.1 mM DTT, 50 μg/ml BSA) and incubated with 1 ml of 8.0 units/μl Klenow fragment and 1 mM dNTP at 20 °C for 30 minutes. The filling in reaction was terminated by incubation at 70 °C for 5 min. The resulting 127 bp blunt ended fragment was phenol-extracted, digested with 40 units KpnI in 50 μl of a low salt buffer (10 mM Tris-HCl, pH 7.5, 10 mM MgCl₂, 1 mM DTT) for 1 hr at 37 °C, incubated with 2.5 units bacterial alkaline phosphatase at 65 °C for 30 min and then applied on 1 % preparative agarose gel and electrophoresed. The 110 bp fragment containing the BSF-2 leader sequence was electroeluted and ethanol-precipitated. - The 110 bp fragment was dissolved in 10 μl of ligation buffer (50 mM Tris-HCl, pH 7.4, 10 mM MgCl₂, 10 mM DTT, 1 mM spermidine, 1 mM ATP, 0.1 mg/ml BSA) and ligated with 1 μg of KpnI and SmaI digested pGEM4 by incubating with 200 units of T4 ligase at 4 °C for 16 hrs and transfected into E.coli (MC1065). From the obtained colonies four colo-

nies were picked up, one clone was selected, propagated and after confirmation that the plasmid of this selected clone contained only one leader sequence, it was named as pBSF2-L8 (see Figure 3).

b) 80 μ g of plasmid LE-392 or pGEM4(pFc_R-1) were digested with 150 units of HindIII in 200 μ l of a low salt buffer (10 mM Tris-HCl, pH 7.5, 10 mM MgCl₂, 1 mM DTT) at 37°C for 1 hr and applied on 1 % preparative agarose gel electrophoresis. The HindIII fragment containing the soluble Fc_R region was electroeluted from the gel, ethanol-precipitated and dissolved at a concentration of 1 μ g/ μ l in TE buffer. 1 μ g of the HindIII fragment was incubated with 8.2 units Klenow fragment and 1 mM dNTP in 10 μ l of 1 x nick translation buffer at 20°C for 30 min to fill in the recessive 3'-ends, phenol-extracted and ethanol-precipitated. The HindIII fragments, the 3'-ends of which had been filled in, were digested with 2 units PstI in 10 μ l of the medium salt buffer (50 mM NaCl, 10 mM Tris-HCl, pH 7.5, 10 mM MgCl₂, 1 mM DTT) at 37°C for 1 hr, incubated with 0.25 unit bacterial alkaline phosphatase at 65°C for 30 min and ethanol-precipitated. Separately, 1 μ g of pBSF2-L8 was digested with 2 units BamHI in 20 μ l of a high salt buffer at 37°C for 1 hr, phenol-extracted and ethanol-precipitated. The BamHI-digested pBSF2-L8 was dissolved in 10 μ l of 1 x nick translation buffer and incubated with 8.0 units Klenow fragment and 1 mM dNTP at 20°C for 30 min to fill in the recessive 3'-ends, phenol-extracted and ethanol-precipitated. The precipitate was dissolved in 20 μ l of a high salt buffer, digested with 2 units PstI at 37°C for 1 hr, phenol-extracted and ethanol-precipitated. - The PstI-digested fragment containing the soluble Fc_R coding region and PstI digested pBSF2-L8 were ligated by incubating with 200 units T4 ligase in 10 μ l of ligation buffer at 4°C for 16 hrs and transfected into E.coli (MC1065). Eight colonies were picked up from the obtained colonies. One clone was selected, propagated and after confirmation of the plasmid construction named psFc R-1. The propagated psFc_R-1 contains seven bases from the multiple cloning into pGEM4 between BSF-2 leader and Fc_R sequences in frame (see Figure 1: nucleotides 137 to 143).

Example C

Construction of pSV2-gpt-dhfr plasmids

a) 5 μ g of the expression vector pSV2 gpt (see Science 209, 1422 (1980)) were digested with EcoRI and BamHI in a solution containing 100 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl₂, 100

μ g/ml gelatine and 6 mM β -mercaptoethanol at 37°C over night. After precipitation of the DNA with ethanol at -70°C the DNA was incubated with 5 units of Klenow fragment in a solution containing of 7 mM MgCl₂, 7 mM Tris-HCl (pH 7.5), 50 mM NaCl, 1 mM DTT and 50 μ M dNTP for 15 minutes at 37°C. After inactivation of the enzyme at 68°C for 10 minutes 1/10 volume of Tris-HCl (pH 8.0) and 20 units of calf intestine alkaline phosphatase were added. Incubation was performed at 37°C for 2 hours. Subsequently the solution containing the desired DNA was extracted twice with phenol and applied on a 1 % agarose gel. The modified linearized plasmid was electroeluted.

b) 5 μ g of pBR322-dhfr plasmid (see Mol. Cell. Biol. 6, 425-440 (1986)), containing the gene for the dhfr (dihydrofolate reductase) and the corresponding regulatory region derived from hamster cells, were digested with 25 units of FspI and 60 units of HindIII in 100 μ l of a solution containing 10 mM Tris-HCl (pH 7.5), 50 mM NaCl, 6 mM MgCl₂, 6 mM β -mercaptoethanol and 100 μ g/ml gelatine over night at 37°C. After ethanol precipitation the generated DNA fragment (2658 base pairs) was made blunt-ended and purified as described above.

c) The dhfr fragment and the modified pSV2 gpt vector were ligated in 10 μ l of ligase buffer (40 units ligase, 50 mM Tris-HCl (pH 7.5), 10 mM MgCl₂, 20 mM DTT, 1 mM ATP, 50 μ g/ml BBA) at 14°C over night and used for transformation into E.coli JM 101. After restriction enzyme analysis with EcoRI and MstII two positive clones differing in the orientation of the dhfr-gene (in respect to SV40 ORI) were selected. These vectors were designated pSV2-gpt-dhfr17 resp. pSV2-gpt-dhfr20.

d) 5 μ g of one of the pSV2-gpt-dhfr plasmids were digested with 20 units of Apal in 100 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl₂, 6 mM β -mercaptoethanol and 100 μ g/ml gelatine for 2 hours at 37°C. After Klenow fill in reaction for 25 minutes at 20°C with 5 units Klenow enzyme in the same reaction mixture and the presence of 5 μ M of dNTP the DNA was extracted with phenol/chloroform and finally collected by ethanol precipitation. The obtained DNA was dissolved in 10 μ l of 100 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl₂, 6 mM β -mercaptoethanol and 100 μ g/ml gelatine and incubated with 20 units of HindIII at 37°C for 2 hours. After inactivation of the enzyme at 70°C for 10 minutes 20 units of calf intestine alkaline phosphatase were added and the reaction mixture was further incubated for 30 minutes at 37°C. The mixture containing the desired DNA was extracted with phenol/chloroform two times and finally applied to a 1 % agarose gel. The pSV2-dhfr vector, which does not contain the gpt gene, was purified by electroelution (see Figure 7).

Example 1Construction of PDE-2sFc_εR

20 µg of the expression vector PDE-2 (see Japanese Patent Publication 1986/88879) were digested with 40 units of EcoRI in a total volume of 100 µl containing 50 mM NaCl, 100 mM Tris-HCl pH 7.5, 5 mM MgCl₂ and 100 µg/ml BSA at 37°C for two hours. Following extraction with phenol/chloroform the DNA was recovered by ethanol precipitation. The digested DNA was dissolved in 25 µl and was treated with 20 units of bacterial alkaline phosphatase at 65°C for 30 minutes and phenol/chloroform extracted twice and ethanol precipitated. In parallel an EcoRI fragment of psFc_εR-1 plasmid (see Figure 4) was produced as follows: 20 µg of psFc_εR-1 were digested with 20 units of EcoRI in 100 µl of 50 mM NaCl, 100 mM Tris-HCl pH 7.5, 5 mM MgCl₂ and 100 µg/ml BSA at 37°C for two hours. Both the vector and the insert DNA were applied on 1 % preparative agarosegel and electrophoresed. The 1.5 kb EcoRI fragment of psFc_εR-1 (consisting of the BSF-2 leader and sFc_ε-sequence) and the linearised PDE-2 vector were electroeluted and ethanol precipitated. The dephosphorylated linearised vector was ligated with the 1.5 kb EcoRI fragment by incubating with 200 units of T4 ligase in 20 µl of ligation buffer (50 mM Tris-HCl pH 7.4, 10 mM MgCl₂, 20 mM DTT, 1 mM spermidin, 1 mM ATP and 100 µg/ml BSA) at 4°C for 16 hours and transfected into E.coli. Restriction enzyme analysis was performed to identify the correct insert. One positive clone was selected and named as pDE-2sFc_εR. The resulting expression vector PDE-2sFc_εR was utilized for expression in monkey Cos-7 cells according to known methods.

Example 2Construction of πsFc_εR

After digestion of 5 µg of the expression vector πH3M (see Proc. Natl. Acad. Sci. 84, 3365-3369 (1987)) with 20 units of XhoI for two hours at 37°C in a solution containing 50 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl₂, 6 mM β-mercaptoethanol and 100 µg/ml gelatine, the linearized plasmid was made blunt-ended with Klenow fragment in the presence of 5 µM of dNTP at 20°C for 25 minutes. Subsequently the vector was treated with bacterial alkaline phosphatase, extracted with phenol and precipitated.

In parallel 5 µg of the plasmid psFc_εR-1

(containing the soluble part of the Fc_ε-receptor gene and the BSF-2 leader sequence upstream of the gene) were digested with 20 units of EcoRI at 37°C for 2 hours in the buffer as described above. After Klenow fill in reaction the DNA fragment was electroeluted from an agarose gel. The linearized, dephosphorylated πH3M vector was ligated to the BSF-2/sFc_ε-DNA fragment in 20 µl of 50 mM Tris-HCl (pH 7.5), 10 mM MgCl₂, 20 mM DTT, 1 mM ATP, 50 µg/ml BSA and 40 units of T4 DBA ligase at 14°C over night. The resulting plasmid was transformed into E.coli and propagated.

Example 3Expression of PDE-2sFc_εR

Cos-7 cells (5 x 10⁵ cells per plate, diameter 60 mm) were seeded onto 60 mm plates one day prior to transfection. Transfection was carried out with 2 µl of plasmid DNA in 1 ml of 25 mM Tris-HCl (pH 7.5), 137 mM NaCl, 5 mM KCl, 0.6 mM Na₂HPO₄, 0.5 mM MgCl₂, 0.7 mM CaCl₂ and 500 µg of DEAE-dextran (Pharmacia Fine Chemical). After 1 hour incubation at 37°C, the solution was replaced with DMEM containing 10 % FCS and 150 µM chloroquine, incubated at 37°C for 3 hours and then replaced with fresh DMEM containing 10 % FCS. One day after transfection the medium was changed to contain 1 % or 10 % FCS in DMEM. The culture supernatants were collected 2 days following the medium change and tested for soluble Fc_εR activity.

Similar results were obtained with πsFc_εR transfected Cos-7 cells.

Example 4IgE rosette formation and its inhibition

For IgE rosette inhibition, 25 µl of Fc_εR bearing cells (5x10⁶/ml) are mixed with a specific volume (e.g. 100 µl) of test sample or control medium and incubated for 1 hour at 4°C. The number of rosettes with 3 or more ORBC are counted. The results are shown in Table I. In experiments I and II the Fc_εR bearing cells are the EoL-3 cells. The control medium is the supernatant of the control Cos-7 cells, i.e. non-transformed cells.

Example 5

Enzyme Linked Immunosorbent Assay (ELISA)

96 well microtiter plates were initially coated with the monoclonal antibody 3-5 100 μ l/well (10 μ g/ml) in coating buffer (NaHCO_3 0.1 M, pH 9.6), and incubated overnight at 4 °C. The plates were then washed 4 times with rinse buffer, i.e. Dulbecco's phosphate buffer pH containing 0.05 % Tween 20, followed by the addition of 100 μ l test sample diluted with diluent buffer (Tris-HCl 0.05 M, pH 8.1, MgCl_2 1 mM, NaCl 0.15 M, Tween 20 0.05 % (v/v), NaN_3 0.02 %, BSA 1 %). The microtiter plates were incubated for 2 hours at room temperature, and washed 4 times with rinse buffer, followed by the addition of 100 μ l of pretitrated and diluted goat-anti-mouse IgM-alkaline phosphatase conjugates. The plates were incubated for two hours at room temperature and washed 4 times with rinse buffer. In the final step 100 μ l of substrate, p-phenyl phosphate disodium (1 mg/ml) in substrate buffer (NaHCO_3 0.05M, pH 9.8, $\text{MgCl}_2 \times 6 \text{ H}_2\text{O}$, 10 mM) was added and the colorimetric reaction measured every 30 minutes for two hours at 405 and 620 nm. The results of $\text{Fc}_\epsilon\text{R}$ activity are shown on Figure 6.

Example 6

Construction of pSV2-dhfr-sFc $_\epsilon$

10 μ g of the π H3M plasmid (containing the soluble part of the Fc_ϵ -receptor gene which upstream is ligated to the BSF-2 leader sequence) were digested with PstI in 50 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl_2 , 6 mM β -mercaptoethanol and 100 μ g/ml gelatine for 2 hours at 37 °C. After incubating the reaction mixture with 5 units of Klenow enzyme for 25 minutes at 20 °C in the presence of 50 μ M of dNTP to create blunt ends, the DNA was extracted with phenol and precipitated with ethanol. The obtained DNA was dissolved in 20 μ l of a solution consisting of 100 mM NaCl, 10 mM Tris-HCl (pH 7.5), 6 mM MgCl_2 , 6 mM β -mercaptoethanol and 100 μ g/ml gelatine and incubated with 20 units of HindIII at 37 °C for 2 hours. After phenol/chloroform extraction the reaction mixture containing the desired DNA was applied on a 1 % agarose gel and a 1500 base pair fragment was electroeluted. After ligation of the 1500 bp fragment into the linearized pSV2-dhfr vector (lacking the gpt gene) in 10 μ l of 50 mM Tris-HCl (pH 7.5), 10 mM MgCl_2 , 20 mM DTT, 1 mM ATP and 50 μ g/ml BSA and 40 units of T4 DNA ligase at 14 °C over night the ligation mixture was used to transform E.coli HB 101. After restriction enzyme analysis a positive clone was selected

and designated pSV2-dhfr-sFc $_\epsilon$ (see Figure 7).

Example 7

Expression of pSV2-dhfr-sFc $_\epsilon$

Chinese hamster ovary cells deficient in dihydrofolate reductase (dhfr $^-$, Chasin, L.) were propagated in α -MEM medium containing 10 % foetal calf serum, Hypoxanthine and Thymidine (HT). Transfection of the plasmid pSV2-dhfr17-sFc $_\epsilon$ or pSV2-dhfr20-sFc $_\epsilon$ into CHO cells was performed by the calcium phosphate precipitation method (see Virology 52, 456 (1973)). 7×10^5 cells were seeded on culture plates one day prior transfection. Cells were exposed to a calcium phosphate precipitate containing 10 μ g of plasmid DNA for 4 hours at 37 °C. Subsequently the medium was aspirated and replaced by selection medium α -MEM with 10 % foetal calf serum, which was changed every 2 days. Colonies of transformed cells appeared 12 to 16 days later and were isolated with cloning cylinders or pipette tips. Supernatants were tested soluble for $\text{Fc}_\epsilon\text{R}$ activity by ELISA assays.

Claims

1. A cloned gene operably linked to a replicon and control sequence both suitable for expression in cells of multicellular organisms wherein at least a part of the coding sequence for the amino acids 1 to 148 of the whole $\text{Fc}_\epsilon\text{R}$ -gene as shown in Figure 1 is replaced by an eucaryotic signal sequence or a coding equivalent thereof.

2. The cloned gene of claim 1 wherein said signal sequence is an interleukin cDNA signal sequence, preferably the BSF-2 signal sequence, which is comprised, for example, by the 110 bp KpnI-HinI fragment of the plasmid pBSF-2.38, or a coding equivalent thereof.

3. An expression vector suitable for expression in cells of multicellular organisms containing a cloned gene as claimed in claim 1 or 2 or a coding equivalent thereof.

4. A cell of a multicellular organism transfected with an expression vector as claimed in claim 3.

5. Water-soluble part of human low affinity Fc_ϵ -receptor coded by a DNA-molecule as claimed in claim 1 or 2 and the O-glycosylated derivate thereof.

6. Water-soluble part of human low affinity Fc_ϵ -receptor as claimed in claim 5 wherein said Fc_ϵ -receptor is expressed by a cell line as claimed in claim 4 and the O-glycosylated derivate thereof.

7. Water-soluble part of human low affinity Fc_ϵ -receptor as claimed in claim 6 wherein the expressed peptide has the formula as shown in Figure 4 and the O-glycosylated derivate thereof.

8. Pharmaceutical composition containing a water-soluble Fc_ϵ -receptor as claimed in any of the claims 5 to 7.

9. Use of the water-soluble Fc_ϵ -receptor as claimed in any of the claims 5 to 7 for the preparation of a pharmaceutical composition.

10. A method of preparing a cloned gene as claimed in claim 1 or 2 which comprises ligating a DNA-sequence coding at least the water-soluble part of human low affinity receptor starting with the amino acid 150 as shown in Figure 1 with an eucaryotic signal sequence.

11. A method of preparing an expression vector as claimed in claim 3 which comprises ligating a suitable linearised vector with a cloned gene as claimed in claim 3.

12. A method of preparing a cell line as claimed in claim 4 which comprises transfecting a cell with an expression vector as claimed in claim 3.

13. A method of preparing water-soluble human low affinity Fc_ϵ -receptor as claimed in any of the claims 5 to 7 comprising culturing a transfected cell as claimed in claim 4 and isolating the water-soluble Fc_ϵ -receptor as produced.

14. Preparation of a pharmaceutical composition as claimed in claim 8 which comprises incorporating an effective amount of a water-soluble Fc_ϵ -receptor as claimed in any of the claims 5 to 7 in one or more excipients.

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Figure 1: Scheme of pFc₂R-1

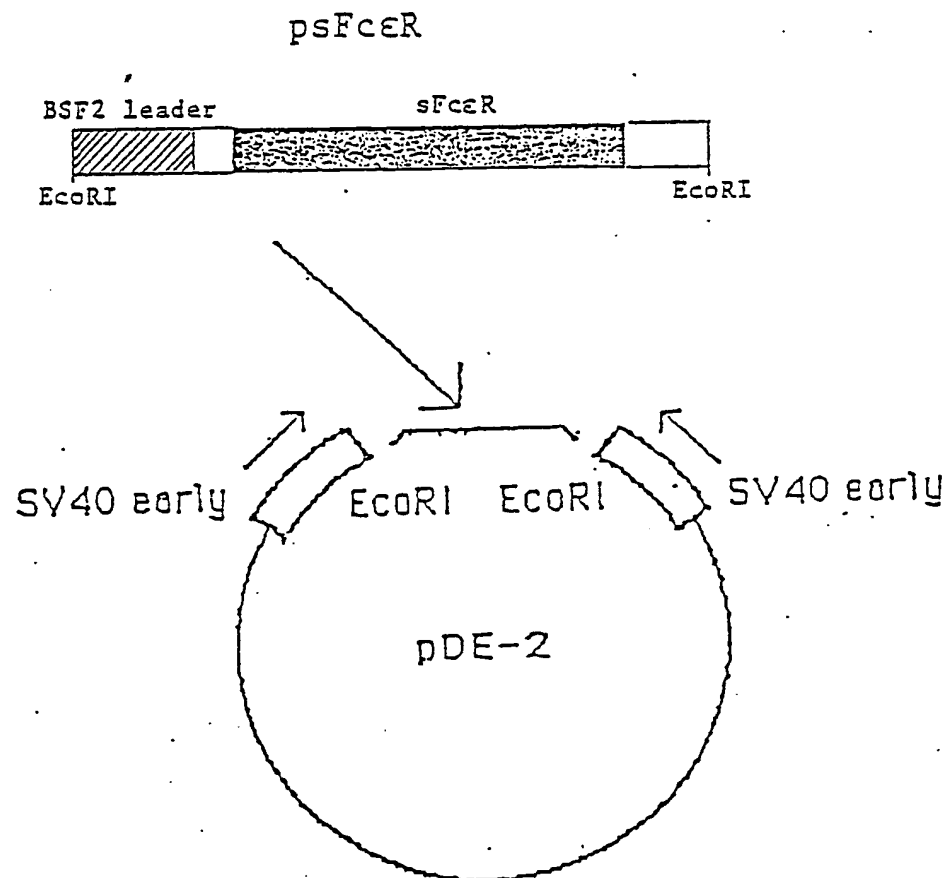
																EcoRI GAATTCCTCCTGCT		8
TAAACCTCTGTCTCTGACGGTCCCTGCCAATCGCTCTGGTCGACCCCAACACACTAGGA																67		
GGACAGACACAGGCTCCAACTCCACTAAGTGACCAGAGCTGTGATTGTGCCCGCTGAG																126		
5	TGGACTGCGTTGTCAGGGAGTGAGTGCTCCATCATCGGGAGAATCCAAGCAGGACCGCC															185		

					170					175					180	
	Lys	Trp	Ile	Asn	Phe	Gln	Arg	Lys	Cys	Tyr	Tyr	Phe	Gly	Lys	Gly	
	AAG	TGG	ATC	AAT	TTC	CAA	CGG	AAG	TGC	TAC	TAC	TTC	GGC	AAG	GGC	725
					185					190					195	
5	Thr	Lys	Gln	Trp	Val	His	Ala	Arg	Tyr	Ala	Cys	Asp	Asp	Met	Glu	
	ACC	AAG	CAG	TGG	GTC	CAC	GCC	CGG	TAT	GCC	TGT	GAC	GAC	ATG	GAA	770
					200					205					210	
	Gly	Gln	Leu	Val	Ser	Ile	His	Ser	Pro	Glu	Glu	Gln	Asp	Phe	Leu	
	GGG	CAG	CTG	GTC	AGC	ATC	CAC	AGC	CCG	GAG	GAG	CAG	GAC	TTC	CTG	815
10					215					220					225	
	Thr	Lys	His	Ala	Ser	His	Thr	Gly	Ser	Trp	Ile	Gly	Leu	Arg	Asn	
	ACC	AAG	CAT	GCC	AGC	CAC	ACC	GGC	TCC	TGG	ATT	GGC	CTT	CGG	AAC	860
					230					235					240	
15	Leu	Asp	Leu	Lys	Gly	Glu	Phe	Ile	Trp	Val	Asp	Gly	Ser	His	Val	
	TTG	GAC	CTG	AAG	GGA	GAG	TTT	ATC	TGG	GTG	GAT	GGG	AGC	CAT	GTG	905
					245					250					255	
	Asp	Tyr	Ser	Asn	Trp	Ala	Pro	Gly	Glu	Pro	Thr	Ser	Arg	Ser	Gln	
	GAC	TAC	AGC	AAC	TGG	GCT	CCA	GGG	GAG	CCC	ACC	AGC	CGG	AGC	CAG	950
20					260					265					270	
	Gly	Glu	Asp	Cys	Val	Met	Met	Arg	Gly	Ser	Gly	Arg	Trp	Asn	Asp	
	GGC	GAG	GAC	TGC	GTG	ATG	ATG	CGG	GGC	TCC	GGT	CGC	TGG	AAC	GAC	995
					275					280					285	
	Ala	Phe	Cys	Asp	Arg	Lys	Leu	Gly	Ala	Trp	Val	Cys	Asp	Arg	Leu	
	GCC	TTC	TGC	GAC	CGT	AAG	CTG	GGC	GCC	TGG	GTG	TGC	GAC	CGG	CTG	1040
25					290					295					300	
	Ala	Thr	Cys	Thr	Pro	Pro	Ala	Ser	Glu	Gly	Ser	Ala	Glu	Ser	Met	
	GCC	ACA	TGC	ACG	CCG	CCA	GCC	AGC	GAA	GGT	TCC	GCG	GAG	TCC	ATG	1085
					305					310					315	
30	Gly	Pro	Asp	Ser	Arg	Pro	Asp	Pro	Asp	Gly	Arg	Leu	Pro	Thr	Pro	
	GGA	CCT	GAT	TCA	AGA	CCA	GAC	CCT	GAC	GGC	CGC	CTG	CCC	ACC	CCC	1130
					320											
	Ser	Ala	Pro	Leu	His	Ser	*									
	TCT	GCC	CCT	CTC	CAC	TCT	TGA	GCATGGATACAGCCAGGCCAGAGCAAGACC								1182
	CTGAAGACCCCCAACCACGGCCTAAAAGCCTCTTTGTGGCTGAAAGGTCCCTGTGACAT															1241
35	TTTCTGCCACCCAAACGGAGGCAGCTGACACATCTCCCGCTCCTCTATGGCCCCCTGCCT															1300
	TCCCAGGAGTACACCCCAACAGCACCCCTCTCCAGATGGGAGTGCCCCCAACAGCACCCCT															1359
	CTCCAGATGAGAGTACACCCCAACAGCACCCCTCTCCAGATGCAGCCCCATCTCCTCAGC															1418

ACCCCAGGACCTGAGTATCCCCAGCTCAGGTGGTGAGTCCTCCTGTCCAGCCTGCATCA 1477

ATAAAATGGGGCAGTGATGGCCTCCCAAAAA ----- 1507

----- AAGGAATTC /Sac/Kpn/ /Pst/Sph/Hind/ -----
EcoRI

Figure 2

											KpnI	Met	Asn	Ser	Phe		
											/Eco/Sac/	GGTACC	ATG	AAC	TCC	TTC	18
5					-20					-15						-10	
	Ser	Thr	Ser	Ala	Phe	Gly	Pro	Val	Ala	Phe	Ser	Leu	Gly	Leu	Leu		
	TCC	ACA	AGC	GCC	TTC	GGT	CCA	GTT	GCC	TTC	TCC	CTG	GGG	CTG	CTC		63
					-5					1						6	
10	Leu	Val	Leu	Pro	Ala	Ala	Phe	Pro	Ala	Pro	Val	Pro	Pro	Gly	Glu		
	CTG	GTG	TTG	CCT	GCT	GCC	TTC	CCT	GCC	CCA	GTA	CCC	CCA	GGA	GAA		108
					11					16						21	
	Asp	Ser	Lys	Asp	Val	Ala	Ala	Pro	His	Arg	Gln	Pro	Leu	Thr	Ser		
	GAT	TCC	AAA	GAT	GTA	GCC	GCC	CCA	CAC	AGA	CAG	CCA	CTC	ACC	TCT		153
					26					31						36	
15	Ser	Glu	Arg	Ile	Asp	Lys	Gln	Ile	Arg	Tyr	Ile	Leu	Asp	Gly	Ile		
	TCA	GAA	CGA	ATT	GAC	AAA	CAA	ATT	CGG	TAC	ATC	CTC	GAC	GGC	ATC		198
					41					46						51	
	Ser	Ala	Leu	Arg	Lys	Glu	Thr	Cys	Asn	Lys	Ser	Asn	Met	Cys	Glu		
	TCA	GCC	CTG	AGA	AAG	GAG	ACA	TGT	AAC	AAG	AGT	AAC	ATG	TGT	GAA		243
20					56					61						66	
	Ser	Ser	Lys	Glu	Ala	Leu	Ala	Glu	Asn	Asn	Leu	Asn	Leu	Pro	Lys		
	AGC	AGC	AAA	GAG	GCA	CTG	GCA	GAA	AAC	AAC	CTG	AAC	CTT	CCA	AAG		288
					71					76						81	
25	Met	Ala	Glu	Lys	Asp	Gly	Cys	Phe	Gln	Ser	Gly	Phe	Asn	Glu	Glu		
	ATG	GCT	GAA	AAA	GAT	GGA	TGC	TTC	CAA	TCT	GGA	TTC	AAT	GAG	GAG		333
					86					91						96	
	Thr	Cys	Leu	Val	Lys	Ile	Ile	Thr	Gly	Leu	Leu	Glu	Phe	Glu	Val		
	ACT	TGC	CTG	GTG	AAA	ATC	ATC	ACT	GGT	CTT	TTG	GAG	TTT	GAG	GTA		378
					101					106						111	
30	Tyr	Leu	Glu	Tyr	Leu	Gln	Asn	Arg	Phe	Glu	Ser	Ser	Glu	Glu	Gln		
	TAC	CTA	GAG	TAC	CTC	CAG	AAC	AGA	TTT	GAG	AGT	AGT	GAG	GAA	CAA		423
					116					121						126	
	Ala	Arg	Ala	Val	Gln	Met	Ser	Thr	Lys	Val	Leu	Ile	Gln	Phe	Leu		
	GCC	AGA	GCT	GTG	CAG	ATG	AGT	ACA	AAA	GTC	CTG	ATC	CAG	TTC	CTG		468
35					131					136						141	
	Gln	Lys	Lys	Ala	Lys	Asn	Leu	Asp	Ala	Ile	Thr	Thr	Pro	Asp	Pro		
	CAG	AAA	AAG	GCA	AAG	AAT	CTA	GAT	GCA	ATA	ACC	ACC	CCT	GAC	CCA		513
					146					151						156	
40	Thr	Thr	Asn	Ala	Ser	Leu	Leu	Thr	Lys	Leu	Gln	Ala	Gln	Asn	Gln		
	ACC	ACA	AAT	GCC	AGC	CTG	CTG	ACG	AAG	CTG	CAG	GCA	CAG	AAC	CAG		558

161 166 171
 Trp Leu Gln Asp Met Thr Thr His Leu Ile Leu Arg Ser Phe Lys
 TGG CTG CAG GAC ATG ACA ACT CAT CTC ATT CTG CGC AGC TTT AAG 603

176 181
 5 Glu Phe Leu Gln Ser Ser Leu Arg Ala Leu Arg Gln Met
 GAG TTC CTG CAG TTC AGC CTG AGG GCT CTT CGG CAA ATG TAGCATG 649

GGCACCTCAGATTGTTGTTGTTAATGGGCATTCCTTCTTCTGGTCAGAAACCTGTCCAC 708

TGGGCACAGAACTTATGTTGTTCTCTATGGAGAACTAAAAGTATGAGCGTTAGGACACT 767

ATTTTAATTATTTTTTAATTTATTAATATTTAAATATGTGAAGCTGAGTTAATTTATGTA 826

10 AGTCATATTTATATTTTAAGAAGTACCACTTGAAACATTTTATGTATTAGTTTTGAAAT 885

AATAATGGAAAGTGGCTATGCAGTTTGAATATCCTTTGTTTCAGAGCCAGATCATTCT 944

TGGAAAGTGTAGGCTTACCTCAAATAAATGGCTAACTTATACATATTTTTAAAGAAATA 1003

TTTATATTGTATTTATATAATGTATAAATGGTTTTTATACCAATAAATGGCATTTTAAA 1062

15 AAATTCAGCAAAAAAAAAAAAAAAAAAAAAAAAAAGGGATCC/Xba/SaI/Pst/Sph/Hin/1100
 BamHI

Figure 4: Scheme of psFc₂R-1

ATTTAGGTGACACTATA																
	EcoRI				KpnI				Met	Asn	Ser	Phe	Ser	Thr	Ser	
5	GAATACACGGAATTTCGAGCTCGGTACCCCT	ATG	AAC	TCC	TTC	TCC	ACA	ACC	51							
	Ala Phe Gly Pro Val Ala Phe Ser Leu Gly Leu Leu Leu Val Leu	12	17	22												
	GCC TTC GGT CCA GTT GCC TTC TCC CTG GGG CTG CTC CTG GTG TTG	96														
10	Pro Ala Ala Phe Pro Ala Pro Val Pro Pro Gly Glu Asp Trp Gly	27	32	37												
	CCT GCT GCC TTC CCT GCC CCA GTA CCC CCA GGA GAA GAT TGG GGA	141														
	Ser Ala Ser Asp Leu Leu Glu Arg Leu Arg Glu Glu Val Thr Lys	42	47	52												
	TCA GCT TCA GAT TTG CTG GAA AGA CTC CGG GAG GAG GTG ACA AAG	186														
15	Leu Arg Met Glu Leu Gln Val Ser Ser Gly Phe Val Cys Asn Thr	57	62	67												
	CTA AGG ATG GAG TTG CAG GTG TCC AGC GGC TTT GTG TGC AAC ACG	231														
20	Cys Pro Glu Lys Trp Ile Asn Phe Gln Arg Lys Cys Tyr Tyr Phe	72	77	82												
	TGC CCT GAA AAG TGG ATC AAT TTC CAA CGG AAG TGC TAC TAC TTC	276														
	Gly Lys Gly Thr Lys Gln Trp Val His Ala Arg Tyr Ala Cys Asp	87	92	97												
	GGC AAG GGC ACC AAG CAG TGG GTC CAC GCC CGG TAT GCC TGT GAC	321														
25	Asp Met Glu Gly Gln Leu Val Ser Ile His Ser Pro Glu Glu Gln	102	107	112												
	GAC ATG GAA GGG CAG CTG GTC AGC ATC CAC AGC CCG GAG GAG CAG	366														
	Asp Phe Leu Thr Lys His Ala Ser His Thr Gly Ser Trp Ile Gly	117	122	127												
	GAC TTC CTG ACC AAG CAT GCC AGC CAC ACC GGC TCC TGG ATT GGC	411														
30	Leu Arg Asn Leu Asp Leu Lys Gly Glu Phe Ile Trp Val Asp Gly	132	137	142												
	CTT CGG AAC TTG GAC CTG AAG GGA GAG TTT ATC TGG GTG GAT GGG	456														
35	Ser His Val Asp Tyr Ser Asn Trp Ala Pro Gly Glu Pro Thr Ser	147	152	157												
	AGC CAT GTG GAC TAC AGC AAC TGG GCT CCA GGG GAG CCC ACC AGC	501														
	Arg Ser Gln Gly Glu Asp Cys Val Met Met Arg Gly Ser Gly Arg	162	167	172												
	CGG AGC CAG GGC GAG GAC TGC GTG ATG ATG CGG GGC TCC GGT CGC	546														
40	Trp Asn Asp Ala Phe Cys Asp Arg Lys Leu Gly Ala Trp Val Cys	177	182	187												
	TGG AAC GAC GCC TTC TGC GAC CGT AAG CTG GGC GCC TGG GTG TGC	591														

					192					197					202	
	Asp	Arg	Leu	Ala	Thr	Cys	Thr	Pro	Pro	Ala	Ser	Glu	Gly	Ser	Ala	
	GAC	CGG	CTG	GCC	ACA	TGC	ACG	CCG	CCA	GCC	AGC	GAA	GGT	TCC	GCG	636
					207					212					217	
5	Glu	Ser	Met	Gly	Pro	Asp	Ser	Arg	Pro	Asp	Pro	Asp	Gly	Arg	Leu	
	GAG	TCC	ATG	GGA	CCT	GAT	TCA	AGA	CCA	GAC	CCT	GAC	GGC	CGC	CTG	681
					222					227						
	Pro	Thr	Pro	Ser	Ala	Pro	Leu	His	Ser	*						
	CCC	ACC	CCC	TCT	GCC	CCT	CTC	CAC	TCT	TGA	GCATGGATACAGCCAGGCC					730
10	CAGAGCAAGACCCTGAAGACCCCCAACCACGGCCTAAAAGCCTCTTTGTGGCTGAAAGG															789
	TCCCTGTGACATTTTCTGCCACCCAAACGGAGGCAGCTGACACATCTCCCGCTCCTCTA															848
	TGGCCCCCTGCCTTCCCAGGAGTACACCCCAACAGCACCCCTCTCCAGATGGGAGTGCCCC															907
	CAACAGCACCCCTCTCCAGATGAGAGTACACCCCAACAGCACCCCTCTCCAGATGCAGCCC															966
	CATCTCCTCAGCACCCCAGGACCTGAGTATCCCCAGCTCAGGTGGTGAGTCCTCCTGTC															1025
15	CAGCCTGCATCAATAAAATGGGGCAGTGATGGCCTCCCAAAAAAAAAA															1071
	- AAAAGGAATTTCGAGCTCGGTACCCGGGGATCCTCTAGAGTCGACCTGCAGGCATGCA															
	AGCTTCCGGTCTCCCTATAGTGAGTCCTATTA															

Figure 5

An Eosinophilic Leukemia Line (EoL-3) Expresses Fc ϵ R

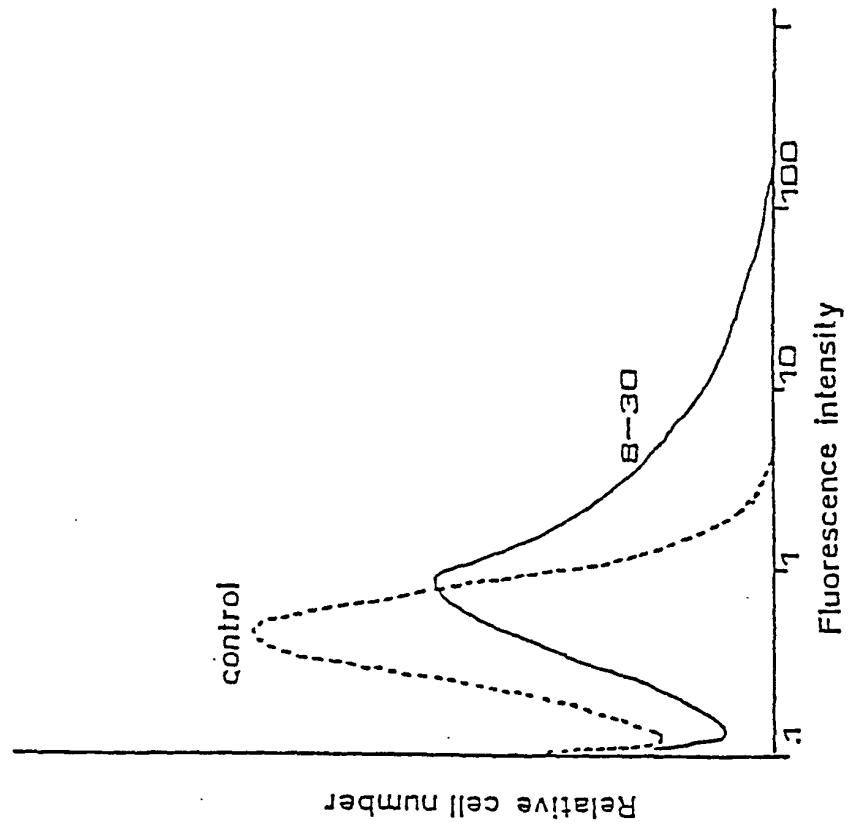


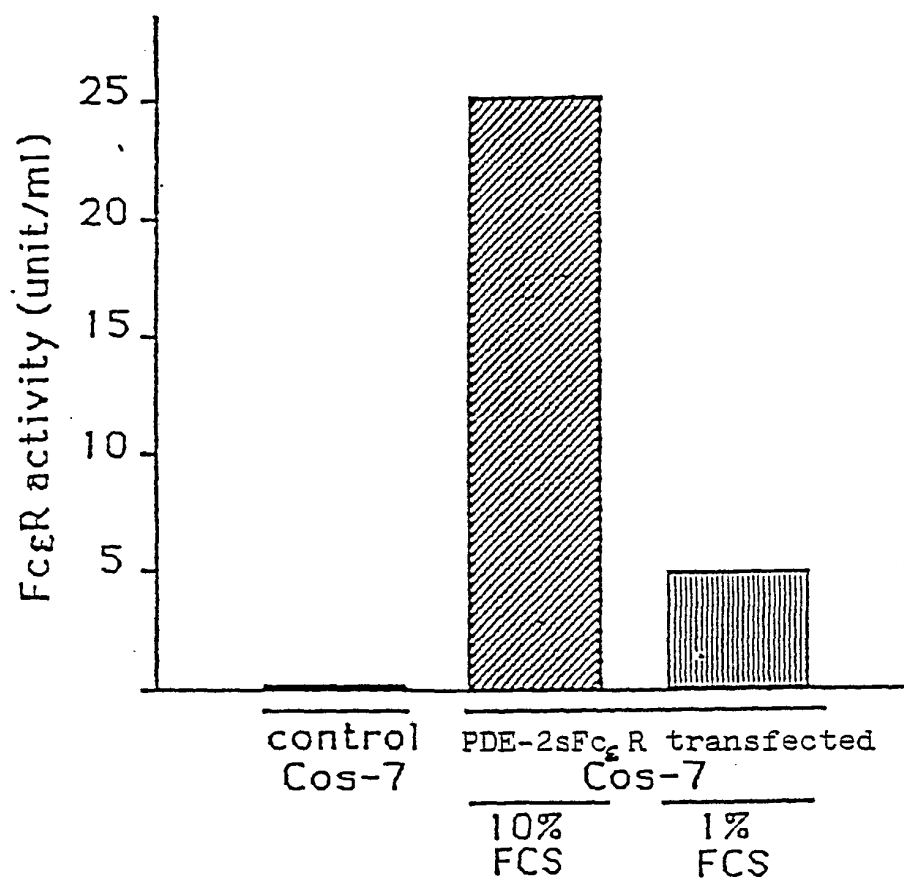
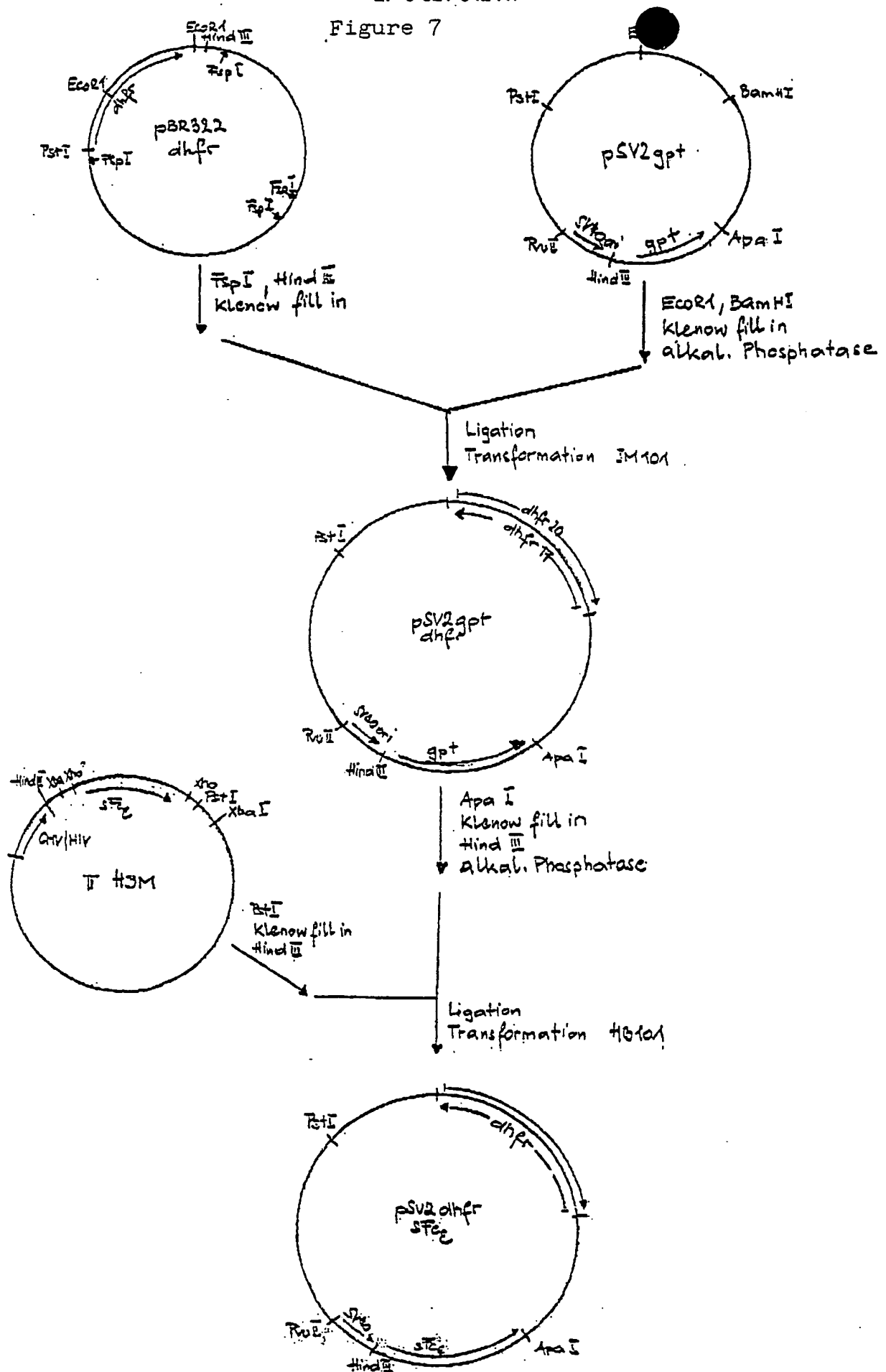
Figure 6

Figure 7



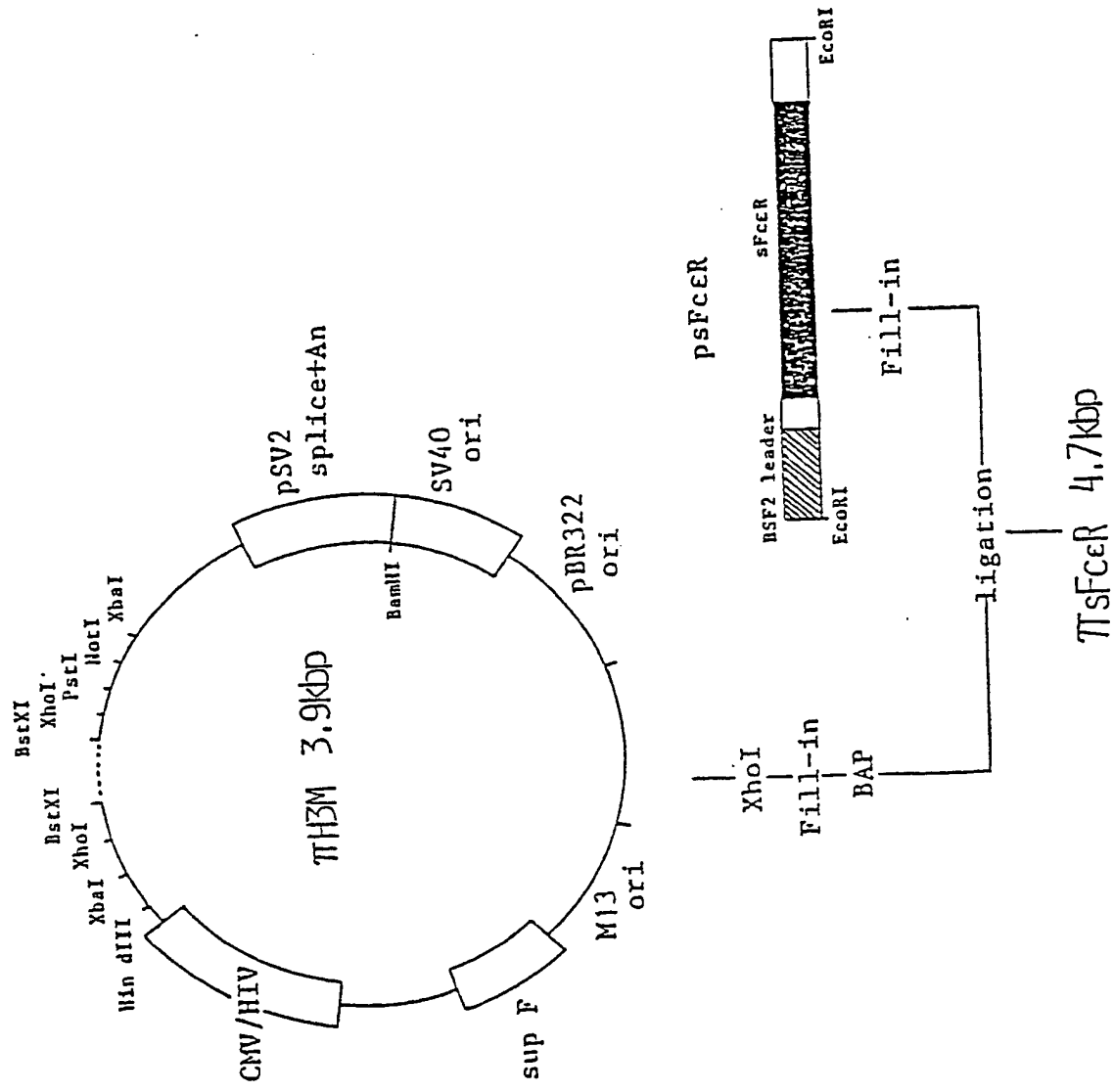


Table I

Inhibition of IgE-rosette formation of EoL-3
cells with recombinant soluble Fc_γR

		Dilutions			
		undiluted	1/3	1/9	1/27
5	Exp. 1 Control	ND	19.6 %	20.2 %	20.1 %
	r Fc_γR	ND	10.0	12.1	14.1
	Exp. 2 Control	22.9	20.9	19.9	18.4
	r Fc_γR	10.1	12.2	14.7	16.4



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X,P	EP-A-0 286 700 (PROF.T. KISHIMOTO) * Whole document *	1-14	C 12 N 15/00 C 12 N 5/00
Y,D	CELL, vol. 47, 5th December 1986, pages 657-665, New York, US; H. KIKUTANI et al.: "Molecular structure of human lymphocyte receptor for immunoglobulin E" * Whole article, especially figure 4 *	1-14	A 61 K 37/02 C 12 P 21/02
Y,D	NATURE, vol. 324, no. 6092, 6th November 1986, pages 73-76; T. HIRANO et al.: "Complementary DNA for a novel human interleukin (BSF-2) that induces B lymphocytes to produce immunoglobulin" * Whole article *	1-14	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			C 12 N C 12 P
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28-03-1989	Examiner CUPIDO M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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